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ANNEALED GLASS.

NO mechanical invention of the present century, relating to any process of manufacture, has given promise in its cradle of working such a revolution in Industrial Art as the method of annealing glass, which has been discovered, and advanced to a high state of practical excellence, by a French gentleman, M. de la Bastie. The most valuable improvements, such as the use of the hot blast in making iron, the electrotype process, the casting steel under pressure, adopted by Sir Joseph Whitworth, and the rapid and exact mode of making steel in twenty-eight minutes, and by a single heat, invented by Mr. Bessemer, have tended to reduce the price, or to increase the excellence, of known materials. But M. de la Bastie has actually presented to the industrial world a new material; a discovery of incalculably more practical value than the chemical detection of a new metal.

The admirable qualities of glass are as well known as are the special peculiarities which have hitherto imposed a sharp limit on the use of this beautiful substance. Durability, which, if not absolute, is measured by centuries rather than by years; unequalled cleanliness; specific gravity of from two and a half to three times the weight of water, or from one-third of the density of iron to one-third of that of hammered copper; hardness that resists the file; great ductility, and fusibility at a heat far below that of most metals; polish of surface; transparency, which grinding reduces to translucency; and capability of receiving the most beautiful and varied colours—these are the chief and distinguishing properties of glass. On the other hand, the high elasticity of the material is limited by its extreme brittleness; and its rapid conducting power is connected with the same fatal defect. A slight blow, or a change of temperature not more sudden than that to which many household utensils are constantly exposed, causes glass to fly into shivers, which, from their sharp edges and points, are very destructive to the human skin, as well as to most materials exposed to the contact.

The annealed glass of M. de la Bastie, while retaining all the qualities mentioned in the first category, has lost those comprised in the second. Its resistance to fracture by blows, as well as to fracture by heat, is increased in a degree which it is not easy to express in figures, but which is higher than that of most ceramic materials. It resists pressure, or impact, we may say, with more tenacity than cast-iron; its non-conducting power appears to be lower than that of earthenware.

A thin plate of annealed glass, of the size of the pane of a greenhouse, or of an old-fashioned casement, when violently thrown on the floor, rebounds with a sound more like that of tin than of any other metal. A lamp-chimney rebounds in the same way. The same plate will bear the weight of a man of twelve stones in the scales, when supported at either end, the weight being put on in the middle. It will resist repeated sharp blows of a hammer. Of these experiments we can personally speak.

Annealed glass is not, of course, absolutely indestructible. We have said that we regard the strength of a good specimen as greater than that of cast-iron of the same dimensions. Like cast-iron, it is capable of fracture by a sufficiently powerful blow. But, unlike any other material with which we are acquainted, when cohesion is overcome, it is overcome altogether. The whole mass crumbles into, not powder, but small cubes, or parallelepipeds, resembling prisms of rock-crystal or fluate of lime, with the remarkable peculiarity that the angles and edges are not cutting. The cohesion seems suddenly to disappear in a manner for which we can cite no precedent. It is obvious that some very extraordinary change in the molecular structure of the material, aptly termed "metal" by glass-workers, is effected by the annealing process. There can be little doubt that the new material, for which we venture to suggest the French name of *verre-Bastie*, is in fact a heteromorphic form of glass; bearing the same kind of relation to the ordinary condition of that composition that the heteromorphic forms of sulphur and of phosphorus bear to the ordinary state of those elements. And, as in those cases, the means of inducing the changed condition is a peculiar mode of abstracting heat. M. de la Bastie plunges the

glass, when heated to a temperature just below that of fusion, into a bath of oil. The suddenness of the immersion and the exact temperature of the glass are the two requisites for the perfect success of the process.

It is remarkable that any inventor who is not himself a glass-manufacturer should have been able to obtain any results that were not uncertain or capricious. It is evident that it is during the making of the articles that the annealing process can be applied, not only most economically, but most certainly. To attain a second heat, as is now done, is an unnecessary expense; not only so, but the probability that the exact degree of heat best suited to the specimen of metal operated on will be attained is small. We have seen that glass varies in specific gravity from 2.5 to 3. That corresponding variations exist in its specific heat there is no doubt. A perfect knowledge of the quality of glass brought to be annealed is requisite in order to ensure the best result from the process. This knowledge is beyond the reach of any but the maker; and, moreover, the careful and intelligent maker.

With regard to the purposes to which the *verre-Bastie* may be applied, we might fill pages with mere enumeration. We will refer to one which has a direct and immediate reference to literature and illustrative art. It is well known that type for printing can be produced in glass; and that glass type has a sharpness and clearness far superior to any that can be obtained from type-metal. But the brittleness of the material is such that the sharp edges are soon destroyed. With annealed glass type, the hardness of the material and sharpness of the definition, the risk of chipping being removed, will produce a page far more beautiful than any printed from metal type. The same remark will apply to stereotypes in annealed glass. Commercially regarded, the gain will be considerable. We conclude that a pound and a half of annealed glass, at least, could be obtained for the price of a pound of type-metal. But then the pound of glass would cast three times as many letters as the pound of metal. Thus for the same price the type-founder would obtain four and a half times as many types, each of tenfold the durability of those which he now uses.

M. de la Bastie's great discovery was attained in the mode in which the most important truths have for the most part been gained; not by chance, not by direct search, but in the intelligent and definite pursuit of another secret of nature. The stories told by Livy and by Petronius, as to the invention of malleable glass, in the reign of the Emperor Tiberius, led to the experiment whether annealing in oil would give that precious quality to the material. Failure in the direction sought was accompanied by this much more valuable result.

As to the limit of the application, the man will be more rash than wise who attempts to fix it. When we see how glass, in spite of its extreme fragility, has so far superseded the use of silver, of earthenware, and of wood, for domestic purposes, we may form a faint idea of what will be the result of the introduction of a material that adds the qualities of metal, without liability to rust or to verdigris, to those of glass and of pottery. For domestic use, from the apparatus of the kitchen to the service of the table, *verre-Bastie* bids fair to displace copper, tin-plate, and porcelain, as being far more durable than either, as well as lighter, cleaner, and more elegant. For cutting purposes, again, the new glass will be used. For surgical instruments it is likely to be invaluable. A circular saw of annealed glass will probably be found the best means of overcoming the great resistance offered by its own substance to cutting; which cannot be done, as with ordinary glass, by the glazier's diamond. As to decorative purposes, it must be remembered that the new glass will serve as a structural material; it will not have to be inserted as a panel, protected from pressure in a frame of wood or metal, but will actually become a builder's material, taking weight like other substances. Indeed, it will be easy to build rooms without windows, except for purposes of ventilation; houses of solid glass, as fairy-like as, but more durable than, the ice palaces of Russia.

F. R. CONDER.